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Dwarfmistletoe of Lodgepole Pine

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Dwarfmistletoe (*Arceuthobium americanum* Nutt. ex Engelm.) causes heavy losses in lodgepole pine essentially throughout the range of this tree. Surveys in Colorado, Wyoming, central Idaho, and western Montana show that from one-third to one-half of the commercial lodgepole pine type is affected to some degree. The Colorado and Wyoming surveys indicate that in merchantable timber the parasite is responsible for about one-third reduction in growth and a marked increase in mortality. It is most damaging in partially cut stands and of least consequence on regenerated burns following holocaustic fires; damage in virgin stands is intermediate.

Host Trees

The principal hosts of this parasite are lodgepole pine and jack pine. It is occasionally found on ponderosa pine, Jeffrey pine, and knobcone pine. Rare hosts are white spruce, Engelmann spruce, limber pine, whitebark pine, and bristlecone pine. In the United States, damage of economic importance is confined to lodgepole pine, but in Canada the losses in jack pine are also significant. *Arceuthobium americanum* has not been found on the low-elevation form of lodgepole pine on the Pacific coast.

[1] Retired from U.S. Forest Service, 1960.

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Appearance of Infected Stands

Recently infected stands show no abnormalities except the inconspicuous dwarfmistletoe shoots on branches and main stems (fig. 1, *A*).

Where the parasite has been present for a long time, the stand will have one or more heavily damaged centers, surrounded by increasingly healthier zones. The centers (fig. 2) are characterized by numerous trees exhibiting witches'-brooms (fig. 3, *A* and *B*) and spike tops (fig. 3, *B*), and by an abnormal number of snags bearing the remnants of witches'-brooms (fig. 3, *C*). Understory trees are likely to have an abundance of dwarfmistletoe shoots. The size of a center depends primarily on time and will vary from a fraction of an acre to a few acres. Large areas of heavy damage result when several centers merge.

Life History of the Pest

Dwarfmistletoe is a parasitic seed plant. It produces delicate, olive-green, leafless, jointed shoots (fig. 1, *A* and *B*) on the stems and branches of the pine. The principal, if not the only, function of these shoots is reproduction. About half of the plants are pistillate; the other half staminate. The plants flower in the spring. The shoots bear the flowers and fruits, but synthesize little carbohydrate food. However, the largest part of an established dwarfmistletoe plant is a network of absorbing strands that lies hidden

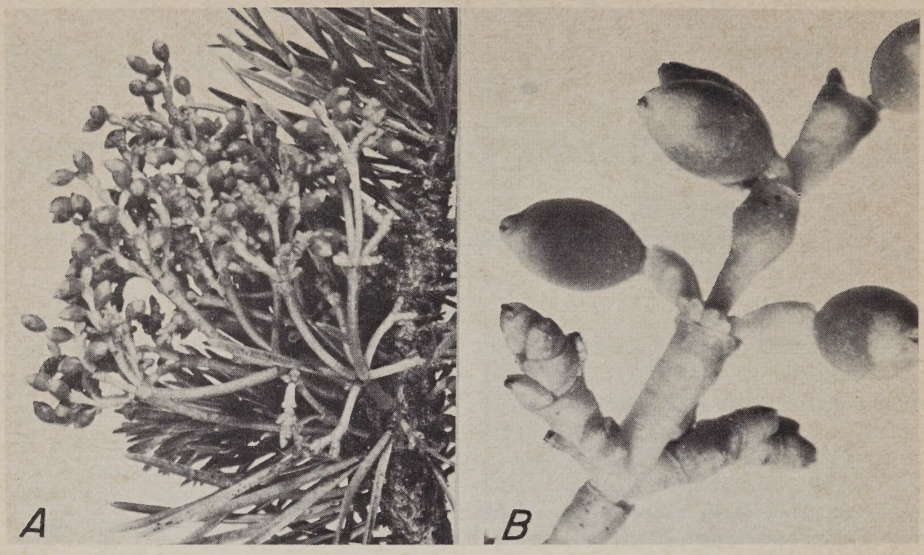

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Figure 1.—Dwarfmistletoe on lodgepole pine: *A*, Aerial shoots on twig (about two-thirds natural size); *B*, pistillate shoot, showing nearly mature, berrylike fruits above and flowers on the two basal side branches (about three times natural size).

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Figure 2.—Damage center of a concentration of dwarfmistletoe in a virgin lodgepole pine stand. In the overstory, mortality is heavy, crowns are low in vigor, and witches'-brooms are common. In such a situation, reproduction will be infected early and probably will die young.

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Figure 3.—*A*, Lower crown of lodgepole pine has large witches'-brooms caused by dwarfmistletoe; upper crown is thin because of scattered infection and because of starvation due to large witches'-brooms. *B*, A heavily infected tree showing witches'-brooms in the lower and midcrown and a dying top. C, Snag killed by dwarfmistletoe. Numerous witches'-brooms occur in the lower crown.

in and gathers nourishment from the bark and wood of the pine.

Seeds are borne singly in berry-like structures that are equipped with an explosive mechanism. At maturity, the elastic outer case of the berry, which is under high hydrostatic pressure, breaks from its base, contracts violently, and flings the seed into the air with a force that may carry it to a neighboring tree. Flights up to 33 feet have been measured in the laboratory. The dispersal period is limited to about 3 weeks in late August and early September. A sticky, hygroscopic substance (viscin) holds the seed fast to the surface on which it alights, and also provides a moist medium for germination. Most of the seeds are first intercepted by the pine needles. The viscous coating surrounding each seed, when moistened by rains, lubricates the seeds so they may slide down the needles. Some seeds fall from the needles and are lost, but many are successfully transferred to the twigs. The seeds that settle on pine stems may germinate in the spring, send their absorbing strands into the bark, and start new plants. An incubation period usually from 3 to 4 years must elapse before the first shoots are produced. Fruits mature about 1½ years after flowers are pollinated.

Spread and Intensification

Intensification and spread depend primarily on the explosive force of the dwarfmistletoe fruits and are therefore decidedly local and limited. Occasional isolated infection centers suggest, however, that the parasite may sometimes be carried long distances by birds or by other means.

The parasite spreads more rapidly in open than in dense stands. Similarly, it spreads faster in multistoried stands than it does in single-storied stands. The most rapid spread is from an open overstory to a vigorous understory.

Studies made in several areas from Colorado to Montana (mainly in stands 10 to 25 years old) showed the following percentages of the total number of infected young trees within various distances of an infected mature stand:

	Percent of infected young trees	
Distance from mature stand (feet):	*Per zone*	*Cumulative total*
0–10	25	25
10–20	39	64
20–30	25	89
30–40	9	98
40–50	1	99
50–60	1	100

Thus, 89 percent of the infected trees were within 30 feet of the mature stand and 98 percent within 40 feet.

About 85 percent of the young stands adjacent to infected overstory trees were infected before they were 10 years old. Because of the long incubation period, however, very little infection is obvious in such young stands. Infection increases rapidly as the stands grow older; it ranged from an average of 3 percent of the trees visibly infected in 10-year-old stands to 32 percent in stands 25 years old. In young stands, beyond the limits of seed discharge from an overstory, the infection spreads at an average of from 10 to 15 feet per decade.

Ecology

Optimum development of dwarfmistletoe is favored by a vigorous host. The most vigorous trees in a stand, therefore, are likely to suffer the greatest damage. Once established on one of these hosts, the parasite is able to continuously reinfect the most vigorous parts of the tree.

Surveys indicate that, in general, the frequency of the parasite is about twice as high on ridges or side hills as on bottom sites. Micro-

climatic effects in these topographic situations appear to be responsible for the differences.

Observations throughout Colorado and Wyoming indicate that dwarfmistletoe has an altitudinal limit of about 300 to 500 feet below the upper commercial limits of lodgepole pine. In some areas, a considerable part of the lodgepole pine type lies in this dwarfmistletoe-free zone. The reasons for the altitudinal limit for dwarfmistletoe have not been determined.

Fire plays a multiple role in the distribution of dwarfmistletoe. Partial burns that leave an open, infected overstory create an ideal situation for heavy and rapid infection of the regenerated stand. Large complete burns, on the other hand, eliminate or so greatly reduce the parasite that it is of no further economic consequence. In such cases, slow invasion of the new stand takes place only from infected trees along the edges of the burn. In another sense, fire also encourages the parasite because it results in the conversion of nonsusceptible types (spruce-fir) to lodgepole pine.

Effect on the Host

The ultimate effect of dwarfmistletoe is premature death of the hosts. The rate at which the parasite kills depends largely upon the age of the host at the time it is first attacked. Young trees tend to succumb quickly. Older ones with well-developed, vigorous crowns may not show appreciable effects from the parasite for years after initial infection. As the parasite spreads through the crown, both by the extension of its absorbing strands in the bark and by reinfection from new seeds, the tree's growth is gradually retarded. Eventually the top weakens and dies, diameter growth virtually stops for several years, and death of the tree follows.

Besides retarding growth and causing death, dwarfmistletoe infection results in defect and degrade in the form of hypertrophies, pitch-soaked stem cankers, and excessively large knots. In some cases, trees are deformed beyond any commercial use.

Studies made of virgin mature stands in Colorado and Wyoming show that heavily infected stands had about half the board foot volume and twice the mortality rate of uninfected stands on the same sites. The average per acre volume for all infected stands was about one-third that of the healthy stands.

Recent studies of immature stands in Colorado indicate that acceptable yields cannot be expected in stands that are infected while they are young. For example, 100-year-old stands that had been infected for 70 years averaged only 300 cubic feet per acre compared with 2,350 cubic feet per acre in healthy stands of the same age on the same sites.

Control

Partial cutting in dwarfmistletoe-infested stands in the past has resulted in vast acreages of heavily infected, multiage stands that are now the most serious dwarfmistletoe problem areas. Partial cutting and thinning creates ideal conditions for maximum damage and should thus be avoided unless the infection is so light that it can be eliminated in the residual trees.

Clear cutting appears to be the best way to control dwarfmistletoe in lodgepole pine. Unless all infected trees are cut or poisoned at the time of logging, however, the sanitation value of the operation will be lost. Any residual infected trees will send showers of seeds into the oncoming reproduction and lead to the development of damage centers in the next generation.

Even where stands are properly clear cut, some dwarfmistletoe will develop in the regenerated stands bordering infected areas in the

residual strips or blocks. In such places, damage to the young stand will be relatively light if the residual blocks are cut within 20 years after the initial logging. If it is possible to cut out the mistletoe on the residual blocks immediately after the initial logging, there should be practically no damage to the regenerated stand for a considerably longer interval.

For greatest benefits, units to be clear cut should have a low ratio of perimeter to area. This can be accomplished by making units as large and compact as possible. Narrow strips should be avoided because too much of the cutover area will be within the infection range from the uncut perimeter. Boundaries should be located in bottoms rather than ridges, and should pass through uninfected stands or natural openings if at all possible.

Because of the long interval between seed germination and appearance of the first shoots, it is virtually impossible to see and destroy all dwarfmistletoe plants in one operation. In general, a second cleaning should be planned for about 5 years after initial control work, but the number and frequency of followup treatments will depend on the intensity of infection in the residual stand, the length of exposure, and the degree to which it is necessary to reduce the parasite populations.

Some of the factors that have hampered dwarfmistletoe control operations in cutover lodgepole pine are (1) work was done under conditions of poor visibility, (2) young infections were missed because of insufficient familiarity with the parasite, and (3) nonmistletoe brooms were sometimes mistaken for those caused by the parasite

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Figure 4.—Stimulation brooms in lodgepole pine. These are frequently mistaken for brooms caused by dwarfmistletoe. Stimulation brooms are common in residual trees in cutover areas. They are usually denser than dwarfmistletoe brooms and commonly occur in formerly suppressed trees or those with dead or broken-out tops.

(fig. 4). These problems emphasize the importance of adequate training and supervision of control crews.

In areas of high tree values, such as recreational, administrative, or homesites, infected branches may be pruned to save lightly infected lodgepole pines. Heavily infected trees must first be destroyed by felling, girdling, or poisoning. Pruning trees that have more than half the crown infected is not advisable. All living branches up to two or more whorls of branches above the highest visibly infected branch should be removed. This will eliminate many latent infections, but the trees should be examined in about 5 years to treat new or overlooked infections.

With branch infections, the distance from the bole to the nearest dwarfmistletoe shoots on the branch shows whether or not the absorbing system has reached the tissues of the mainstem and therefore beyond hope of pruning. As a rule, pruning branches less than 2 inches in diameter can be considered safe if the nearest shoots are not less than 4 inches from the bole. For branches over 2 inches in diameter, a minimum distance of at least 5 or 6 inches is suggested. If these rules are not observed, there is a good chance that pruning will not be effective.

No effective chemical controls have been found. Even if they were available, it is doubtful that they could supplant silvicultural measures and proper management in areas where lodgepole pine is grown as a commercial timber crop.

References

Dwarfmistletoe Brooms and Other Brooms in Lodgepole Pine. Frank G. Hawksworth. U.S. Forest Serv. Rocky Mountain Forest and Range Expt. Sta. Res. Note 59, 3 pp., illus. 1961.

Spread and Intensification of Dwarfmistletoe in Lodgepole Pine Reproduction. Frank G. Hawksworth and Donald P. Graham. Jour. Forestry 61: 587–591, illus. 1963.

Effects of Dwarfmistletoe on Immature Lodgepole Pine Stands in Colorado. Frank G. Hawksworth and Thomas E. Hinds. Jour. Forestry 62: 27–32, illus. 1964.

Dwarf Mistletoes. Job Kuijt. Bot. Rev. 21: 569–627, illus. 1955.

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